Effect of Marine Biogenic Organic Aerosols on Clouds: CAM/MIRAGE study

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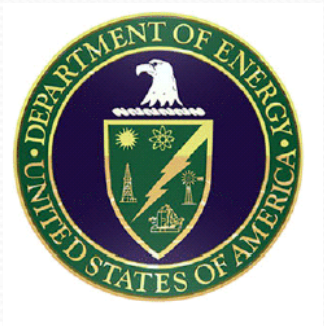

DEPARTMENT OF ENERGY
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Acknowledgments

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Objectives

❖ Can we detect and quantify the imprint of oceanic biological processes on the radiative properties of the overlying aerosols and clouds?

- Develop and implement marine OC aerosol emissions in CAM/MIRAGE

❖ What are the uncertainties in climate simulations due to differences in aerosol activation parameterizations?

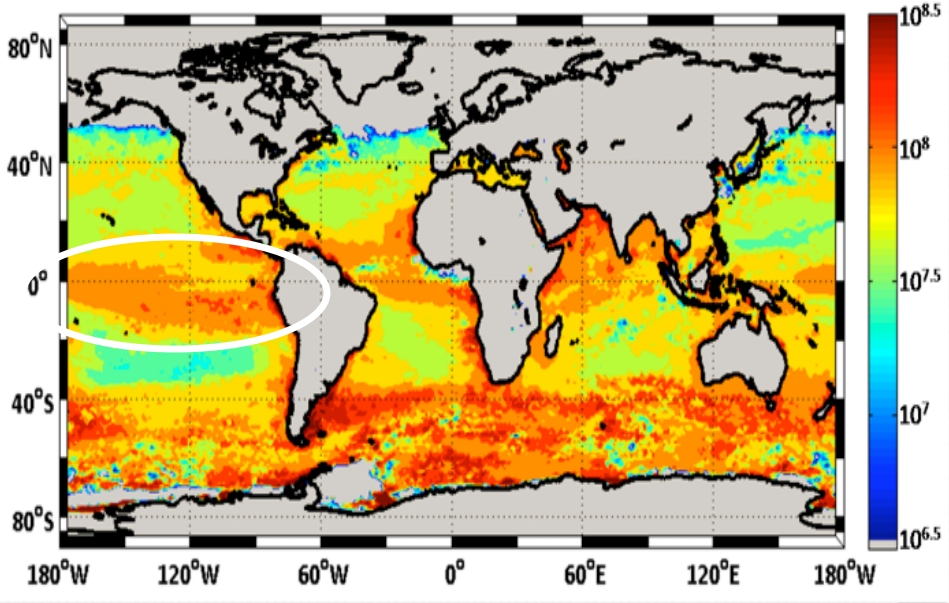
- Implement Fountoukis and Nenes (2005), FN-scheme in CAM/MIRAGE

Global annual total marine emissions

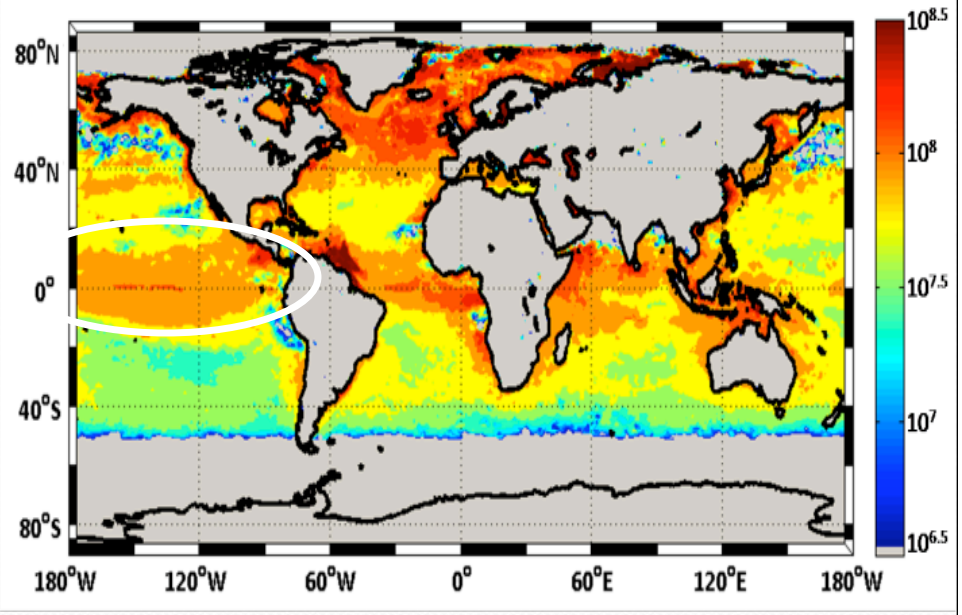
Global Marine Emissions	Estimate	Type	References
Isoprene (Tg C yr^{-1})	1.2	In-situ	Bonsang et al. (1992)
	0.38	In-situ	Milne et al. (1995)
	0.19	In-situ	Broadgate et al. (1997)
	0.42	In-situ	Baker et al. (2000)
	1.1	In-situ	Matsunaga et al. (2002)
	0.1	Remote Sensing	Palmer and Shaw (2005)
	1.2	In-situ	Sinha et al. (2007)
	0.27	Remote Sensing	Arnold et al. (2008)
	1.68	Modeling	Arnold et al. (2008)
	0.92	Remote Sensing	This work
Sub-micron Primary Organic Aerosols (Tg C yr^{-1})	5.5	Remote Sensing	Spracklen et al. (2008)
	2.5	Remote Sensing	Langmann et al. (2008)
	1.26	Remote Sensing	This work
Super-micron Primary Organic Aerosols (Tg C yr^{-1})	19.01	Remote Sensing	This work
Total Organic Aerosols (Tg C yr^{-1})	8	Remote Sensing	Spracklen et al. (2008)
	75	Modeling	Roelofs (2008)
	20.3	Remote Sensing	This work

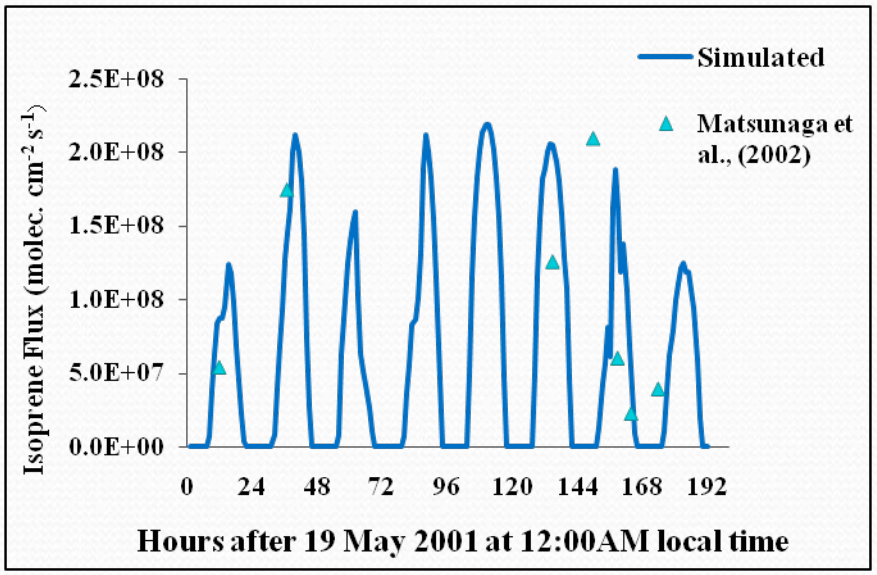
Isoprene Emissions

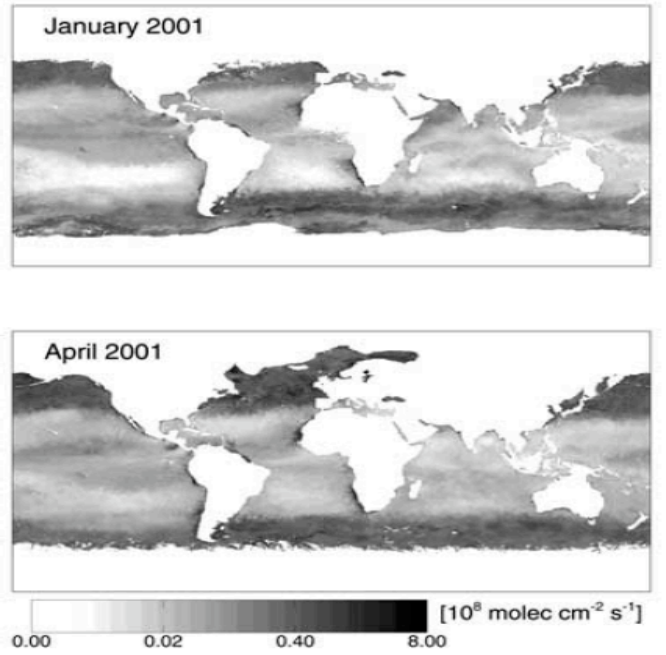
January



July

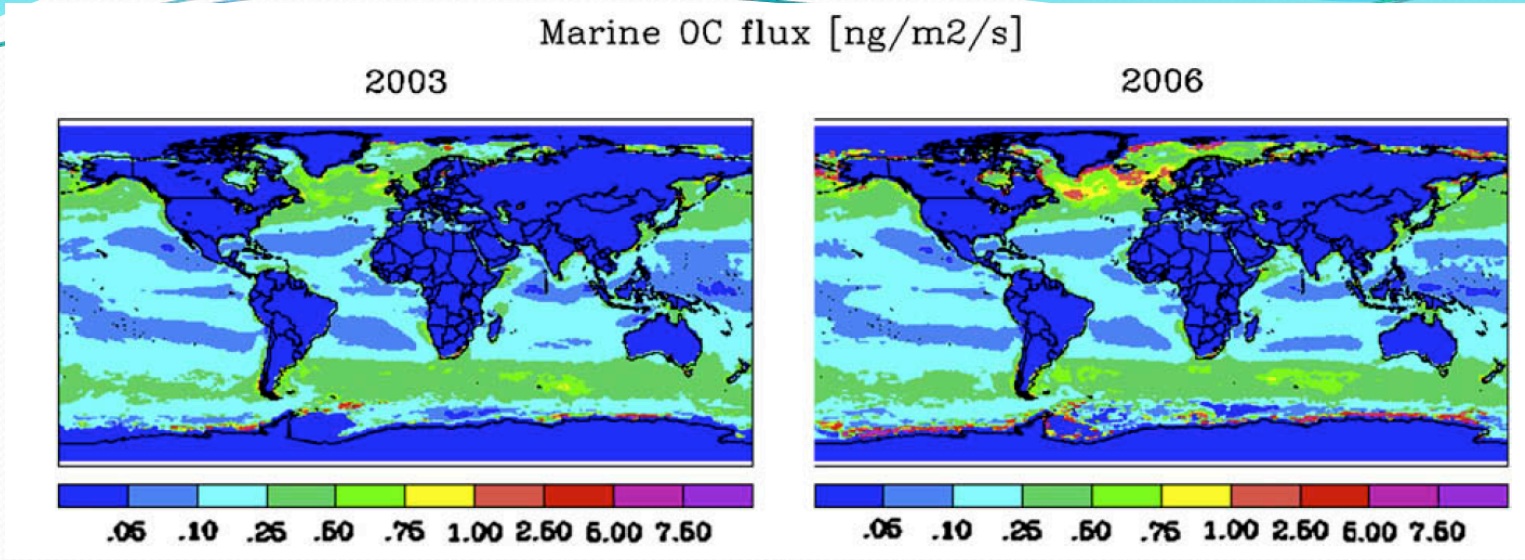






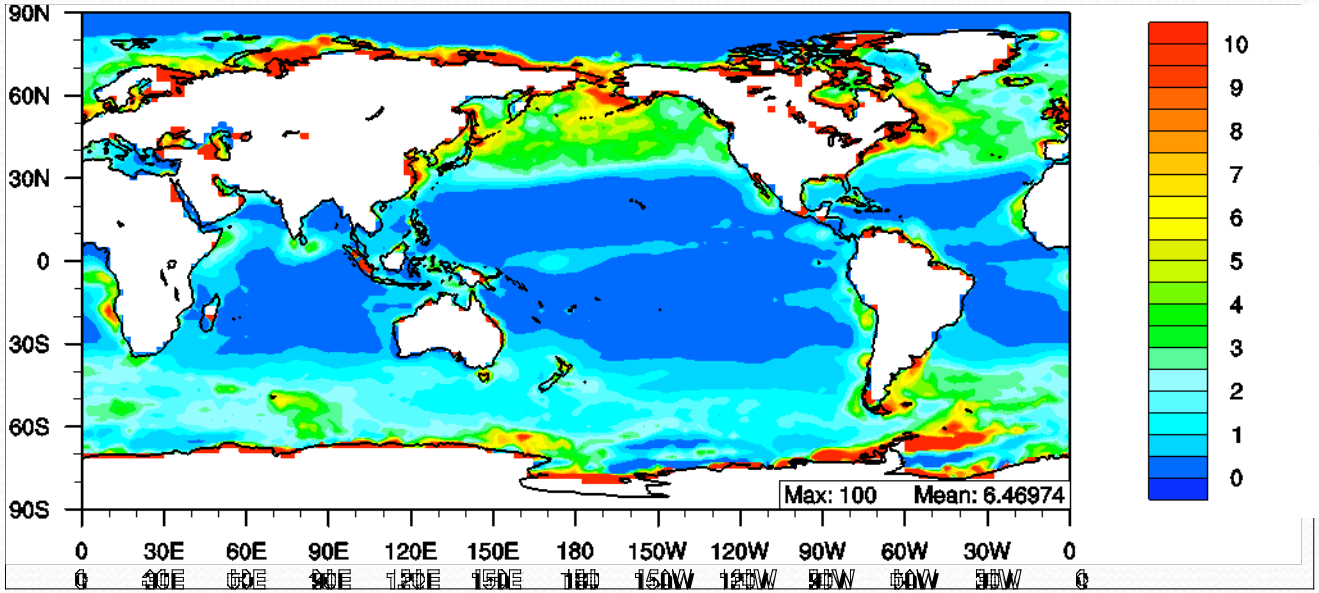
Palmer & Shaw, 2005

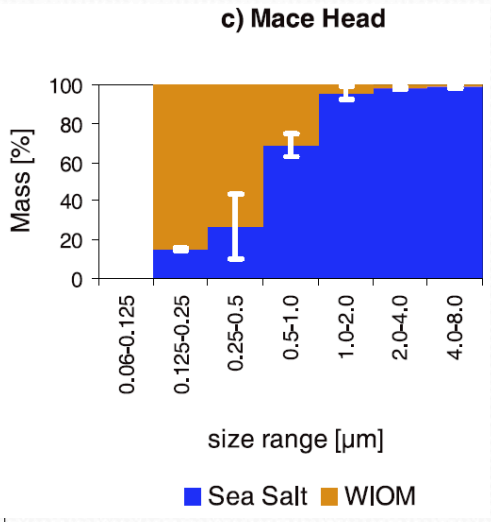
Marine POM emissions (mass)



Relative contribution of marine POM to sea-spray [%]

Langmann et al., 2008

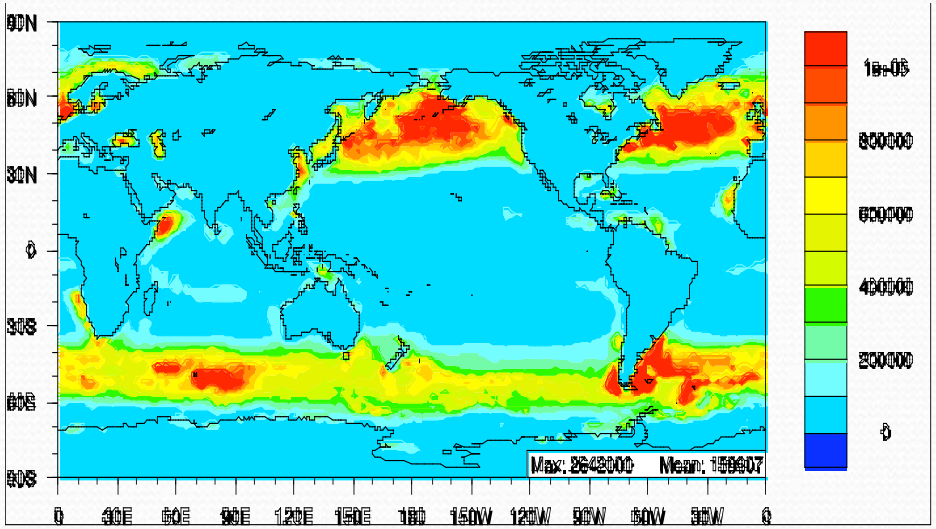




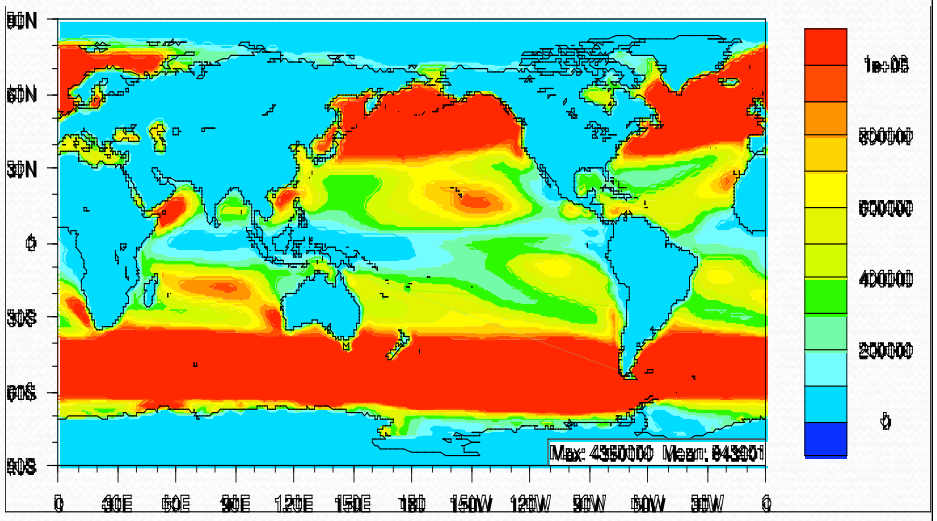
Facchini et al., 2008

Marine POM emissions (number)

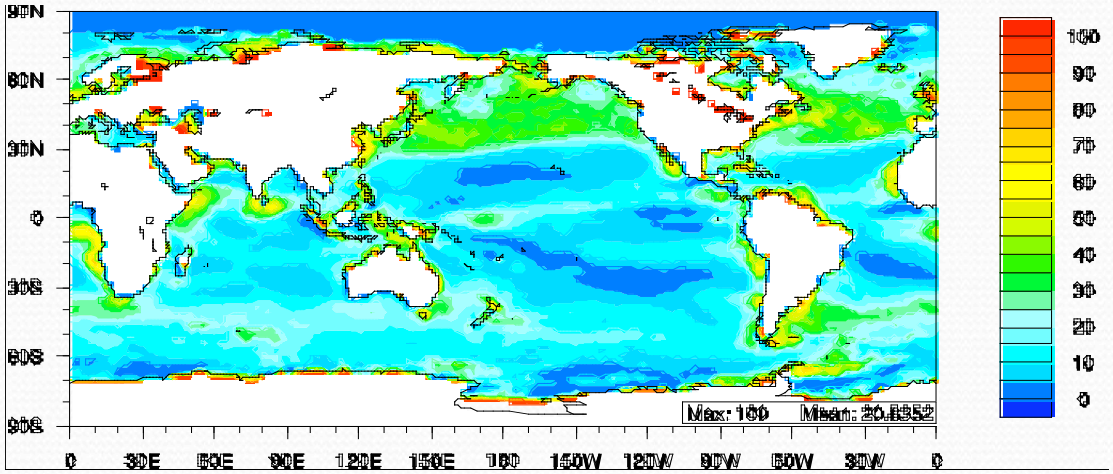
Annual mean marine POM flux [#/m^2/s]



Annual mean sea-salt flux [#/m^2/s]

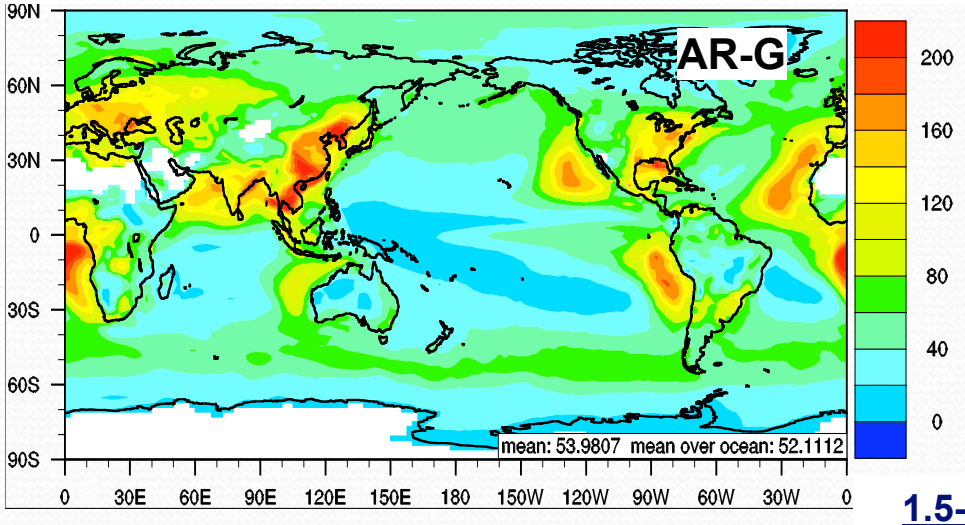


Marine POM emission number contribution to sea-spray [%]

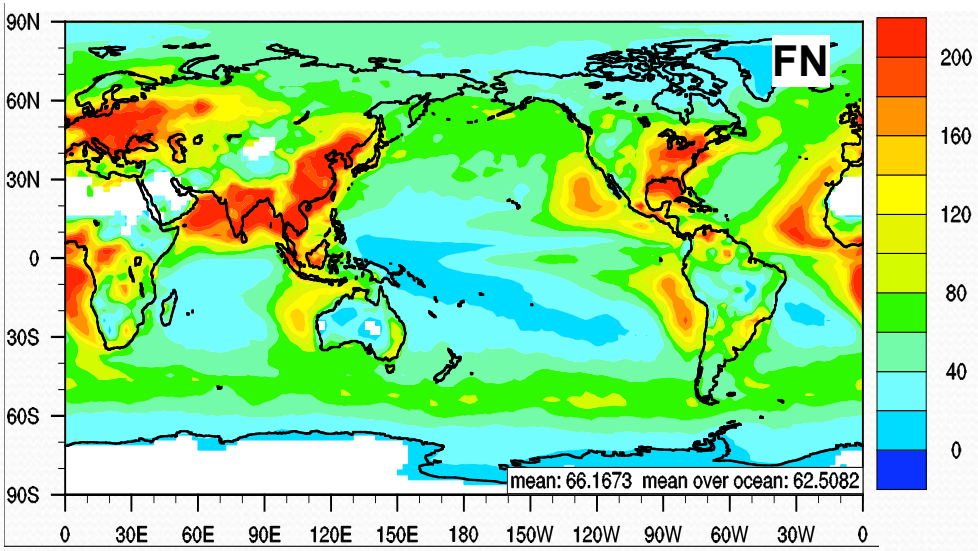


CAM/MIRAGE predicted CDNC with OC aerosols

5-year mean in-cloud CDNC average at 970 and 930 hPa levels
Mean: 54, Mean over ocean: 52, unit: #/cm^3

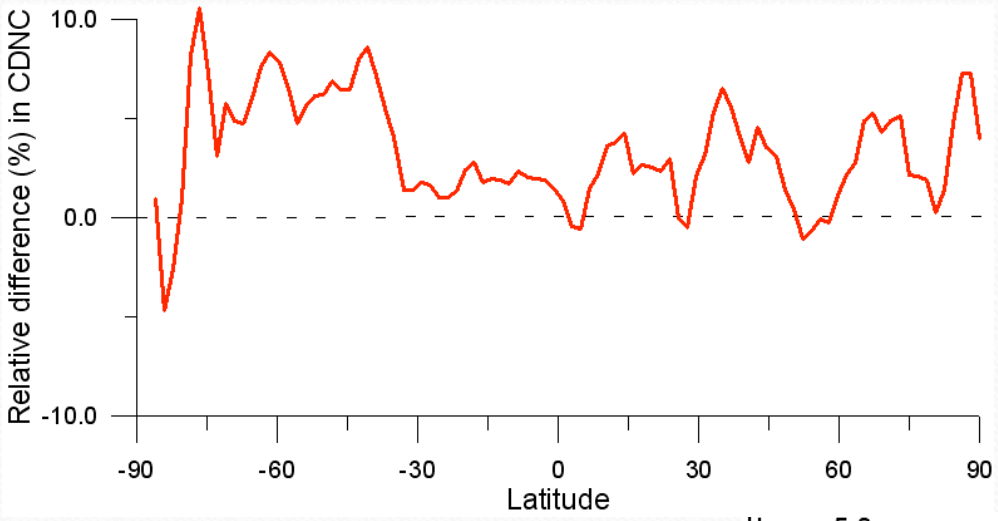


1.5-year mean in-cloud CDNC average at 970 and 930 hPa levels Mean: 66, Mean over ocean: 63, unit: #/cm^3

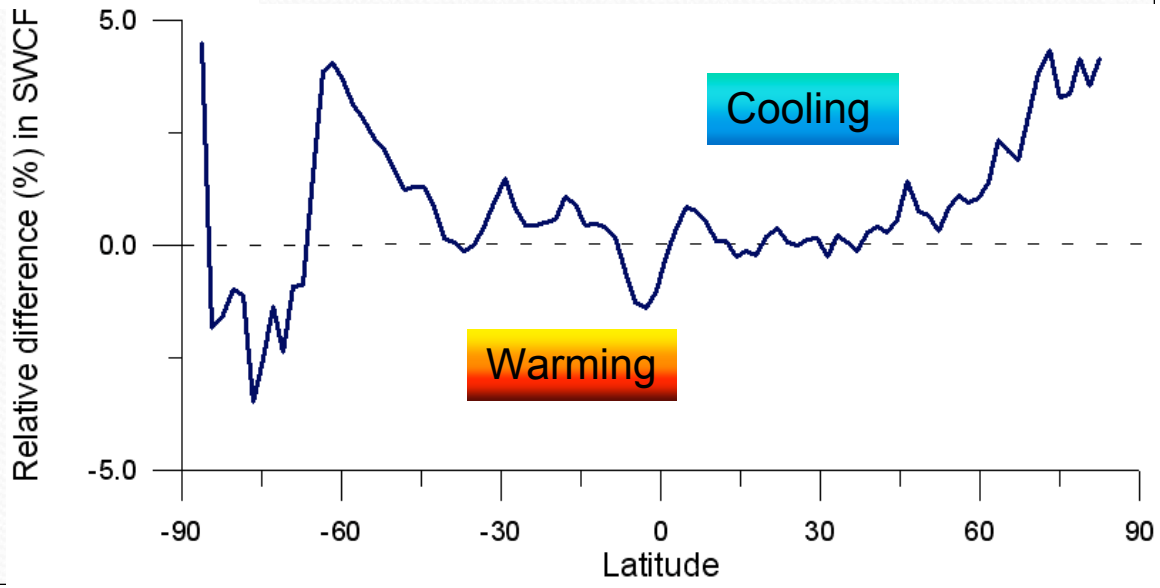


Effects of Marine Organic aerosol on Zonal Mean Values

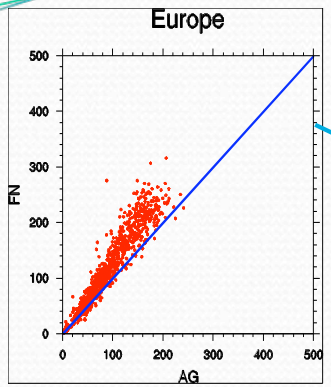
AR-G 5-year mean in-cloud CDNC average at 970 and 930 hPa
Mean: 1.6, Mean over ocean: 2.1, unit: #/cm^3

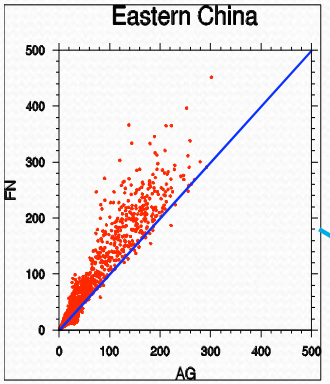


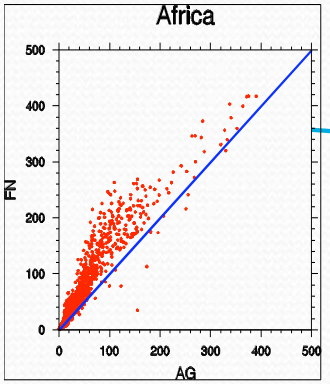
AR-G 5-year mean SWCF mean: -0.45, Mean over ocean: -0.61, unit: W/m^2



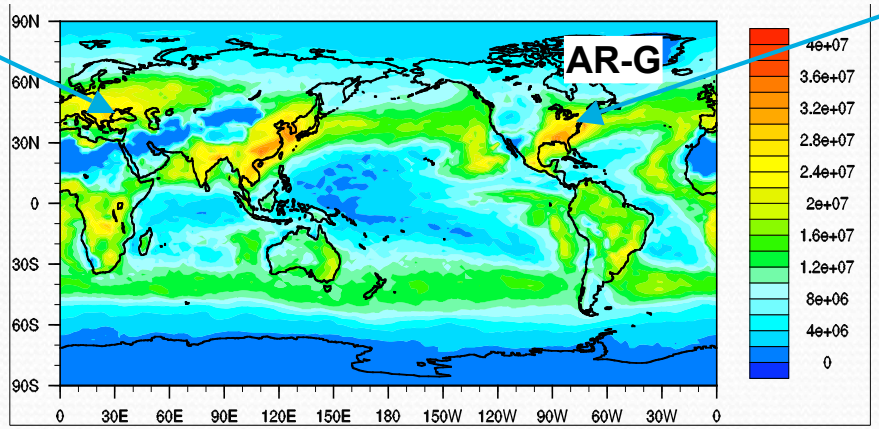
Annual mean column CDNC



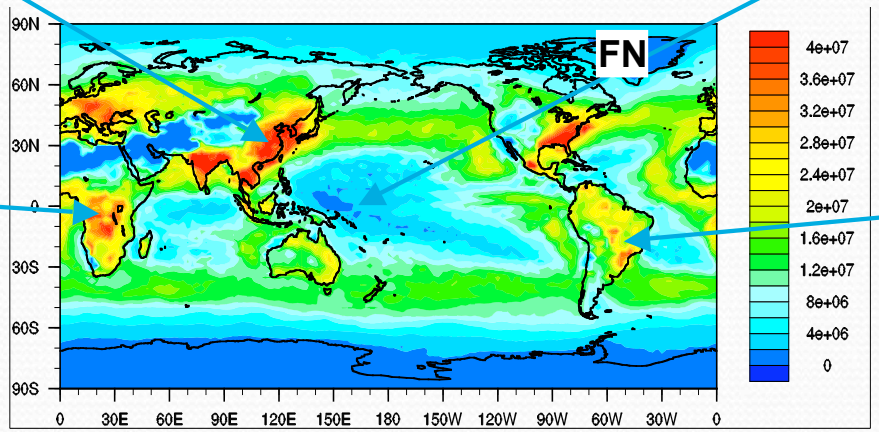


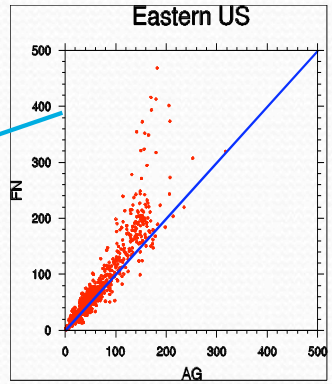


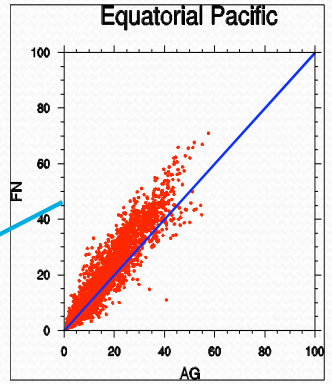
α=1.0, SOA sol 50%, POM sol 0%, mean: 7.95E+6 /cm^2

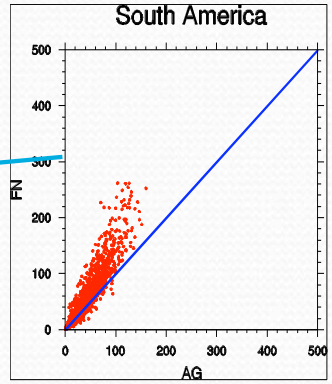


α=1.0, SOA sol 50%, POM sol 0%, mean: 9.44E+6/cm^2



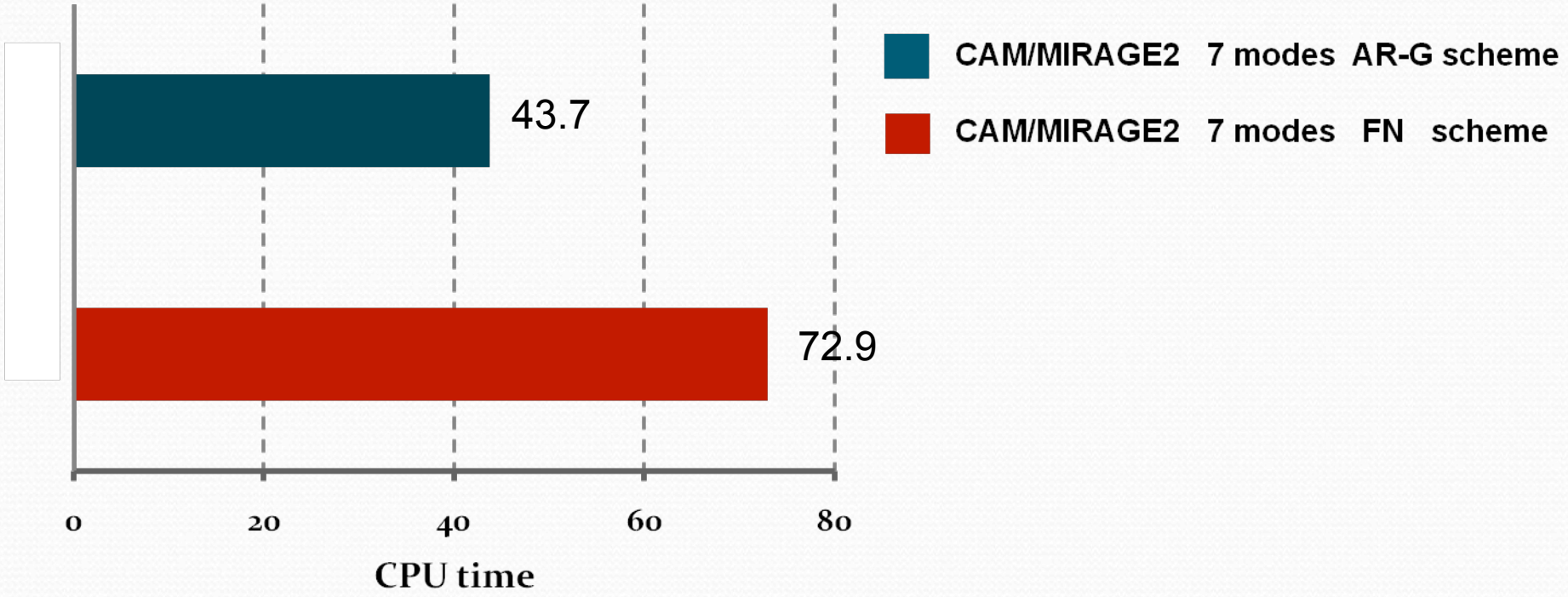






Summary

- Physically-based marine isoprene and POM emissions
- CDNC 3.0 to 6.2 % or 2.1 to 3.1 #/cm^3
- SWCF 0.8% to 1.0 % or -0.36 to -0.45 W/m^2
- Predicted CDNC are sensitive to aerosol activation schemes and aerosol properties:
- FN predicted global mean column CDNC is ~ 20% higher compared to AR-G
- Changing mass accommodation coefficient from 1.0 to 0.06 in FN yields 14% increase in CDNC

Thank you

CPU time in hours for 1 month simulation